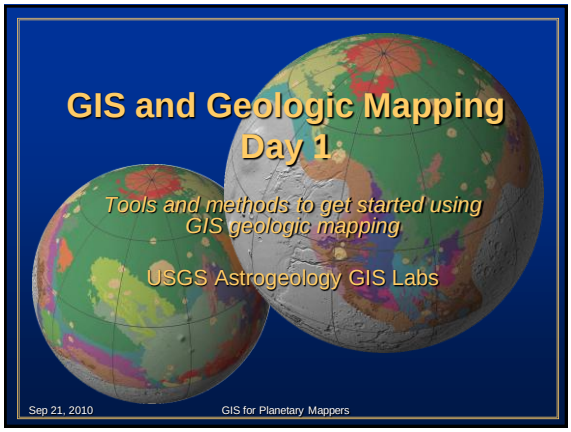


Introduction

- There will be instructional periods to introduce you to the functions of ArcGIS
- Followed by hands-on activities to reinforce concepts
- There will also be Q&A sessions at the end of each session but feel free to ask questions at anytime

GIS for Planetary Mappers 2

Introductions

Teachers

- Trent Hare, Corey Fortezzo, and Jim Skinner
- Students…

GIS for Planetary Mappers 3

Introduction

- Day 1 will include an introduction to GIS, the ArcGIS interface, and the basics of adding and editing data.
- Day 2 will include more advanced topics, e.g., projections, image registration, spatial analysis and geostatistics

GIS for Planetary Mappers 4

Agenda – Day 1

- Class Introduction
- GIS Introduction and Resources
- Just get me started (mapping)
- Editing, Snapping, Streaming

Lunch

- Domains, More Editing
- Building Polygons
- Editing Polygons
- Introduction to Symbols

GIS for Planetary Mappers 5

Agenda – Day 2

- Query and Spatial Analysis
  - Crater/Feature Tools
    - Freie Universität Berlin (Kneissl) /USGS (Nava)
    - Crater density walk-though
- Bringing in Data and Setting Projections
  - Rasters
  - Shapefiles (interpolation)
  - ASCII Files (feature lists, gridded rasters)
  - 3D Viewers

Lunch

- Creating Figures (Layouts)
- GIS Helper Tools
  - Hawths, Geodesic, USGS Image Tools
- ArcMap 10 – what to expect

GIS for Planetary Mappers 6

Some important notes

- USGS Astrogeology primarily uses only one "brand" of GIS (ESRI's ArcMap, levels)
- Other brands exist, both free and commercial
- "Free"
  - Jmars (jmars.asu.edu, Mars, Moon, Earth)
  - Quantum GIS (qgis.org/)
  - UDIG (udig.refractions.net/confluence/display/UDIG/Home)
  - Open EV (openev.sourceforge.net/)
  - JUMP (jump-project.org/)
  - GRASS (grass.itc.it/)
- Commercial
  - TNTmips (www.microimages.com/)
  - ER Mapper (www.ermapper.com)
  - PCI GeoMatica (www.pcigeomatics.com)
  - Global Mapper (www.globalmapper.com)
  - Integraph (www.intergraph.com)

GIS for Planetary Mappers 7

Some important notes *(cont'd)*

- Though this presentation is geared toward geologic mappers, the information is relevant to all GIS users
- Screen-shots are likely to differ from individual views
- GIS skills are developed through software interaction … be patient and try new things!

← Tip icon will point out helpful hints throughout the presentation

GIS for Planetary Mappers 8

GIS Support

- ESRI online portal to technical information
  - *http://support.esri.com*
- ESRI ArcScripts
  - *http://arcscripts.esri.com/*
- ESRI Educational Services
  - Instructor-led training
  - Virtual Campus courses
  - Web workshops
- Books

GIS for Planetary Mappers 9

GIS Support Nodes

- Planet-specific information (*e.g.*, data, discussion, tutorials)
  - *http://webgis.wr.usgs.gov/*
- USGS discussion board (login required)
  - *http://isis.astrogeology.usgs.gov/ … navigate to "Support" → "Planetary GIS Discussions"*

"Plugging keywords into a internet search engine is a great way to search for GIS-related assistance"

GIS for Planetary Mappers 10

Arc Environment "Just get me started…"

- Introduce ArcMap & ArcCatalog interfaces
- Create a FILE Geodatabase (GDB)
- Add attributes (domains)
- Build a feature dataset and add three features (contacts, structures, units)
- Import map bases (raster data)
- Edit the features by adding lines and points (vector data)

GIS for Planetary Mappers 11

GIS - "The horror…the horror…."

- *Organization!!*
- Multi-layer display
- Digitize and edit on-the-fly
- "Easily" generate layouts/figures (Adobe Illustrator compatible)
- Raster and vector analysis
  - Crater counts
  - Spectral statistics for mapped units
  - Endless possibilities
- Editing
  - Set rules for validating data
  - Easily edit/modify existing linework

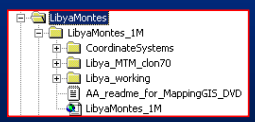
GIS for Planetary Mappers 12

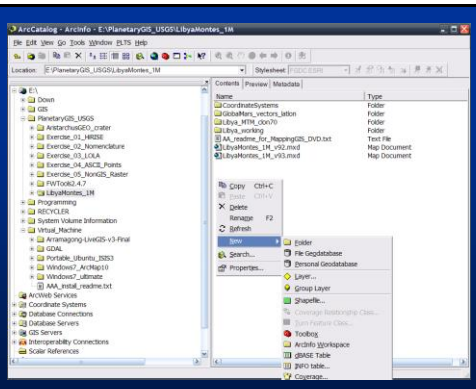
ArcCatalog – your friend

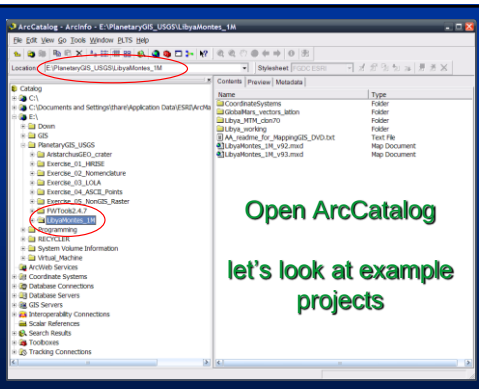
- Separate entity from ArcMap
- Interface is similar to Windows Explorer
  - Create new file
  - Add/Delete folders or files (if unlocked)
  - Good operating environment for ArcToolbox

Libya Montes example

- Six quadrangles
- Mars Transverse Mercator







GIS for Planetary Mappers 16

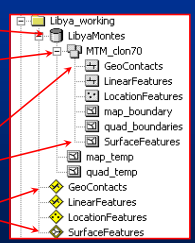
"Geodatabase" ?

- ESRI FILE Geodatabase
- Contains diverse spatial information
  - Vector, raster, tables
  - Topology, toolboxes, domains
- Easily transferable to colleagues
- Easily organized and managed
- Stable

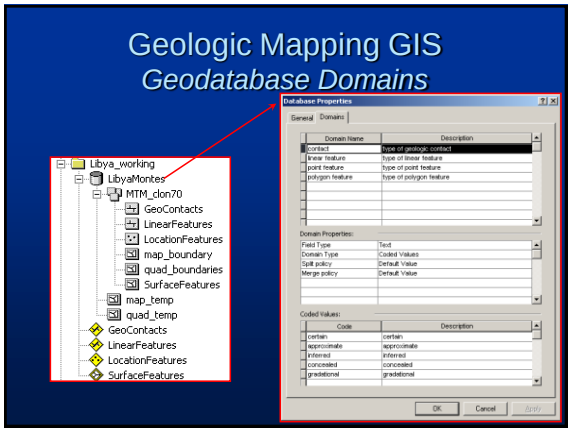
GIS for Planetary Mappers 17

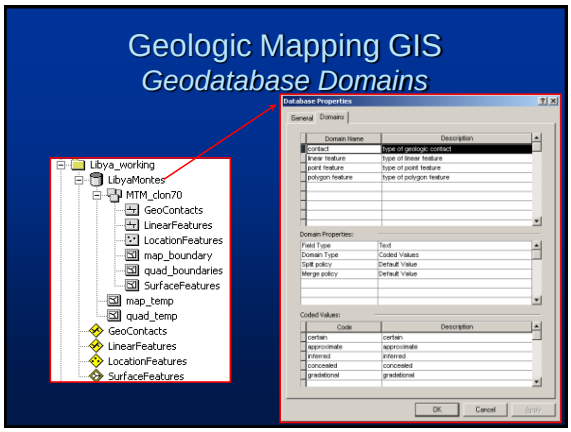
Geologic Mapping GIS
Geodatabase Design

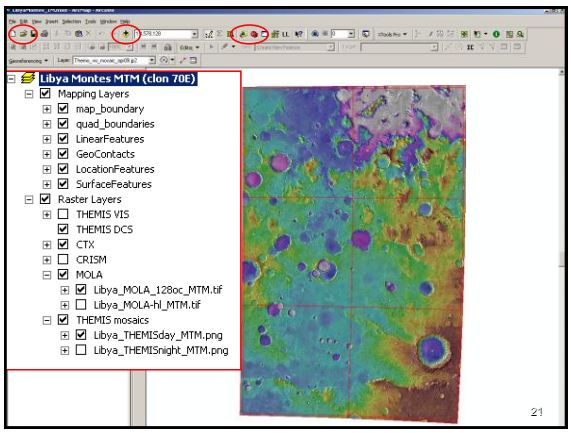
- GDB contains feature attributes as domains
- Feature dataset houses map projection
- Vector layers are pre-built and can be adapted and copied, as needed
- Layer files contain attribute symbols

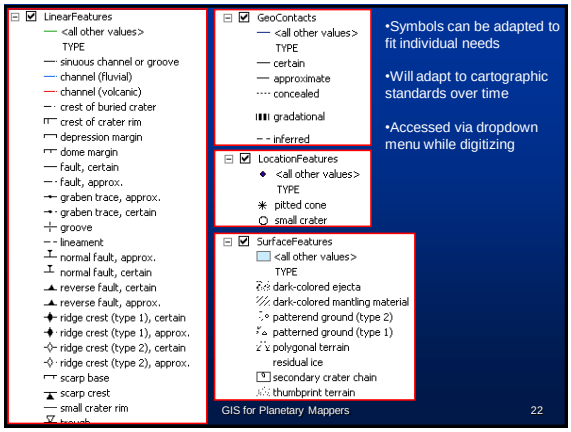


GIS for Planetary Mappers 18


Geologic Mapping GIS
Geodatabase Domains
Libya_working
LibyaMontes
MTM_clon70
GeoContacts
LinearFeatures
LocationFeatures
map_boundary
quad_boundaries
SurfaceFeatures
map_temp
quad_temp
GeoContacts
LinearFeatures
LocationFeatures
SurfaceFeatures
Database Properties
General
Domains
Domain Name
Description
contact
type of geologic contact
linear feature
type of linear feature
point feature
type of point feature
polygon feature
type of polygon feature
Domain Properties:
Field Type
Text
Domain Type
Coded Values
Split policy
Default Value
Merge policy
Default Value
Coded Values:
Code
Description
certain
certain
approximate
approximate
inferred
inferred
concealed
concealed
gradational
gradational
OK
Cancel
Apply


Geologic Mapping GIS
Geodatabase Domains
Libya_working
LibyaMontes
MTM_clon70
GeoContacts
LinearFeatures
LocationFeatures
map_boundary
quad_boundaries
SurfaceFeatures
map_temp
quad_temp
GeoContacts
LinearFeatures
LocationFeatures
SurfaceFeatures
Database Properties
General
Domains
Domain Name
Description
contact
type of geologic contact
linear feature
type of linear feature
point feature
type of point feature
polygon feature
type of polygon feature
Domain Properties:
Field Type
Text
Domain Type
Coded Values
Split policy
Default Value
Merge policy
Default Value
Coded Values:
Code
Description
certain
certain
approximate
approximate
inferred
inferred
concealed
concealed
gradational
gradational
OK
Cancel
Apply


Libya Montes MTM (clon 70E)
Mapping Layers
map_boundary
quad_boundaries
LinearFeatures
GeoContacts
LocationFeatures
SurfaceFeatures
Raster Layers
THEMIS VIS
THEMIS DCS
CTX
CRISM
MOLA
Libya_MOLA_128oc_MTM.tif
Libya_MOLA-hl_MTM.tif
THEMIS mosaics
Libya_THEMISday_MTM.png
Libya_THEMISnight_MTM.png
21



Just Get Me Started

A Quick and Dirty Guide to Mapping in ArcGIS

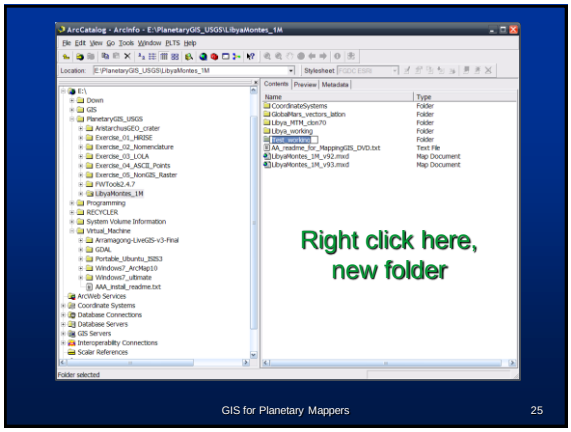
- Introduce ArcMap & ArcCatalog interfaces
- Create a geodatabase (GDB)
- Add attributes
- Build a feature dataset and add three features (contacts, structures, units)
- Add raster data
- Edit features by adding lines and point

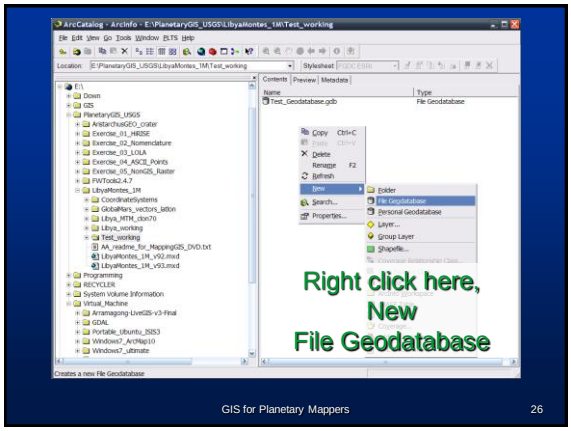
GIS for Planetary Mappers 23

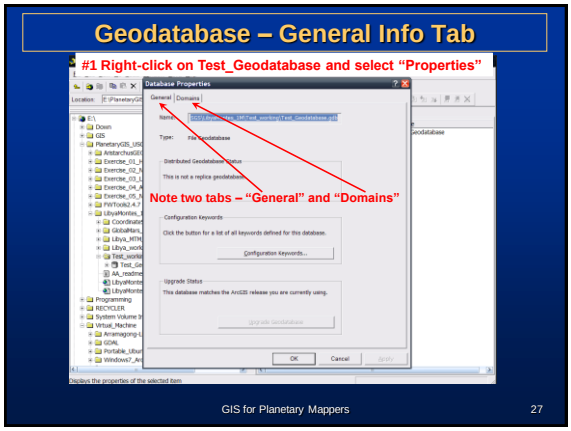
Keys for Success

- Keep project data organized!
- Periodically delete temporary files to avoid clutter
- Use succinct but conspicuous names for folders and files
  - */UtopiaMapProj/June08Lines/geo_contacts_june08.shp*
- Use dual display, if possible (2 screens)
  - *Assists with toggle between programs*
  - *Great for viewing hotlinked images*
- Keep vector data clean
  - *Snap linework!!! – Avoids excessive cleaning at project end*
  - *Experiment with which tolerances work best for your digitizing scale*
- Keep detailed notes on GIS settings, methods, and approaches
- Use point files to hold temporary/evolving geologic units

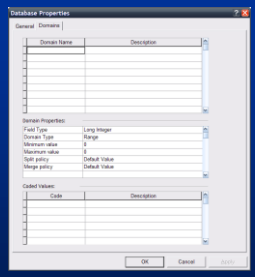
GIS for Planetary Mappers 24


Right click here,
new folder
GIS for Planetary Mappers
25


Right click here,
New
File Geodatabase
GIS for Planetary Mappers
26


Geodatabase – General Info Tab
#1 Right-click on Test_Geodatabase and select "Properties"
Note two tabs – "General" and "Domains"
GIS for Planetary Mappers
27

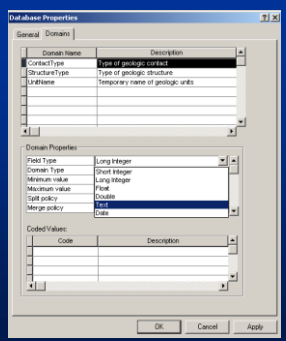
Geodatabase – Domains Info Tab

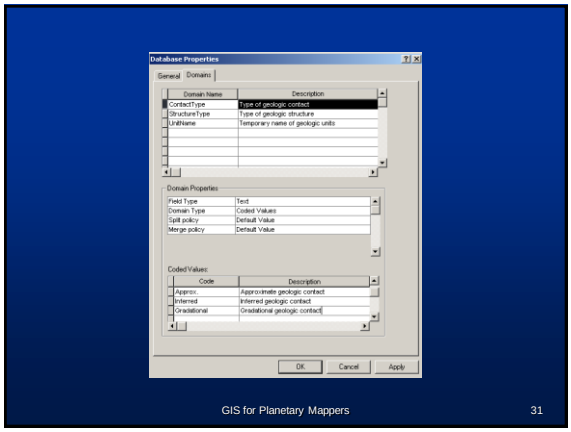


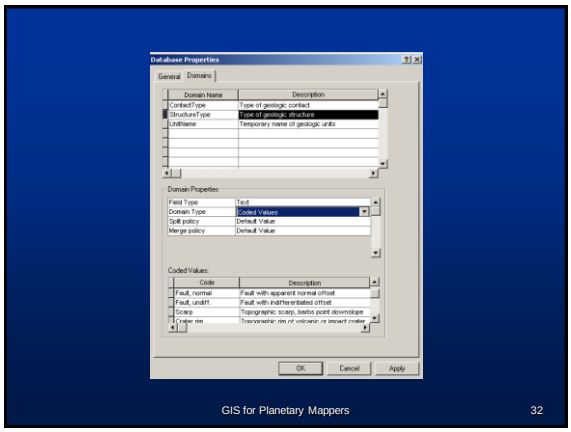
"There is a difference between an attribute domain (described above) and a spatial domain (described later). Use the Arc Help search to see if you can distinguish this important difference"

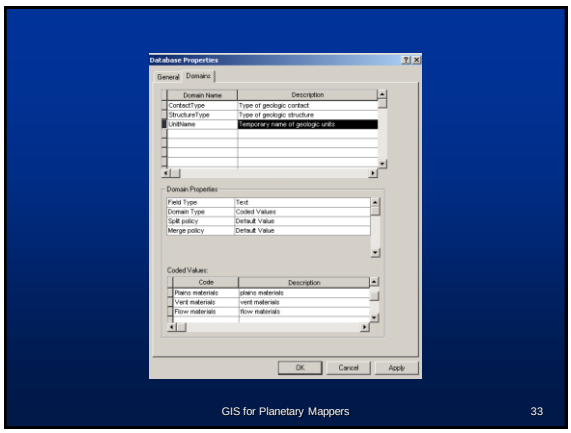
Attribute Domains

- Property of geodatabase
- Offer way to define a range of values that can be used for multiple attribute fields
- Esure data integrity by limiting the choice of values for a particular field
- User restricted to choices available from dropdown list
- Useful for features "known" to exist in a particular map region
  - *Contact attributes (certain, approximate, concealed)*
  - *Structure and feature attributes (ridge, trough, crater rim, flow direction)*
- Can be used for geologic unit attributes, but requires iteration



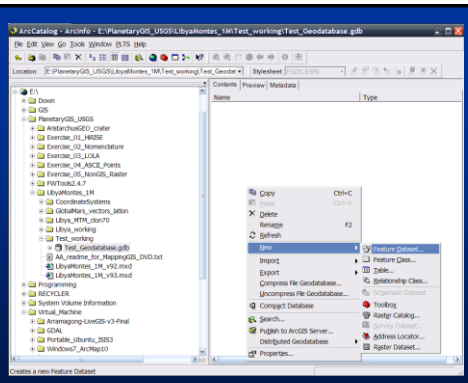

Database Properties
General
Domains
Domain Name
Description
ContactType
Type of geologic contact
StructureType
Type of geologic structure
UnitName
Temporary name of geologic units
Domain Properties:
Field Type
Text
Domain Type
Coded Values
Split policy
Default Value
Merge policy
Default Value
Coded Values:
Code
Description
Approx
Approximate geologic contact
Inferred
Inferred geologic contact
Gradational
Gradational geologic contact
OK
Cancel
Apply
GIS for Planetary Mappers
31

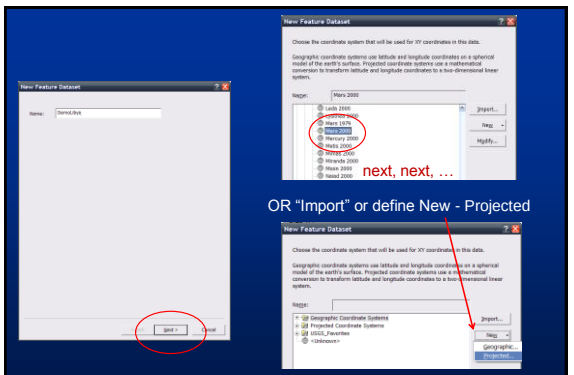

Database Properties
General
Domains
Domain Name
Description
ContactType
Type of geologic contact
StructureType
Type of geologic structure
UnitName
Temporary name of geologic units
Domain Properties:
Field Type
Text
Domain Type
Coded Values
Split policy
Default Value
Merge policy
Default Value
Coded Values:
Code
Description
Fault, normal
Fault with apparent normal offset
Fault, undiff.
Fault with indifferentiated offset
Scarp
Topographic scarp, barbs point downslope
OK
Cancel
Apply
GIS for Planetary Mappers
32

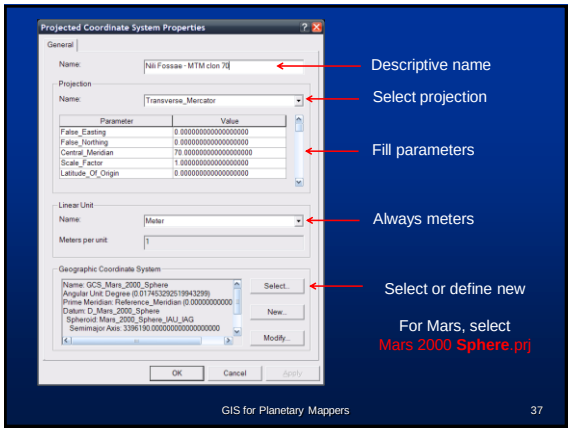

Database Properties
General
Domains
Domain Name
Description
ContactType
Type of geologic contact
StructureType
Type of geologic structure
UnitName
Temporary name of geologic units
Domain Properties:
Field Type
Text
Domain Type
Coded Values
Split policy
Default Value
Merge policy
Default Value
Coded Values:
Code
Description
Plains materials
plains materials
Vent materials
vent materials
Flow materials
flow materials
OK
Cancel
Apply
GIS for Planetary Mappers
33

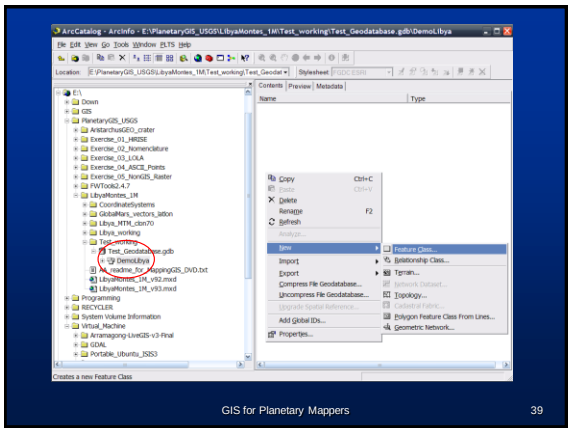
Generate Feature Dataset

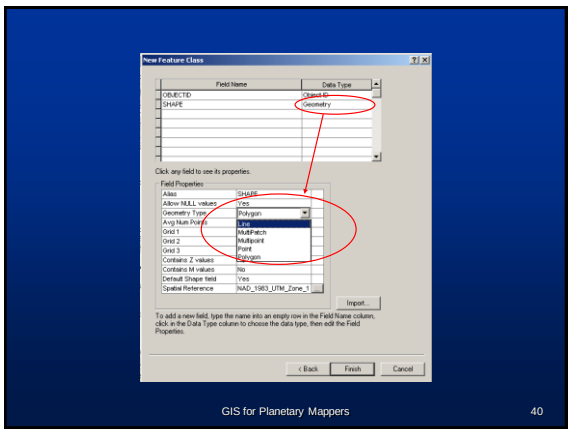
- Geodatabase set
- Domains set
  - Contacts
  - Structure
  - Temporary unit names
- Next…Create a group of affiliated spatial information…a dataset of features (polygons, lines, points)

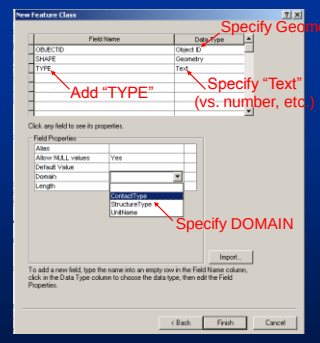




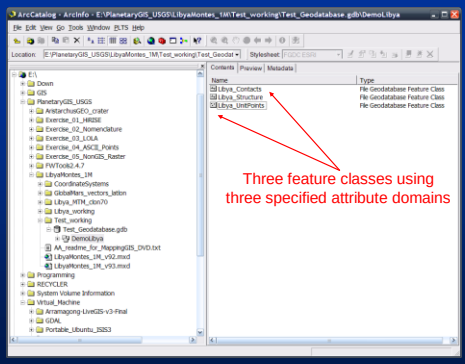

Projected Coordinate System Properties
General
Name:
Nili Fossae - MTM clon 70
Projection
Name:
Transverse_Mercator
Parameter
Value
False_Easting
False_Northing
Central_Meridian
Scale_Factor
Latitude_Of_Origin
Linear Unit
Name:
Meter
Meters per unit:
Geographic Coordinate System
Name: GCS_Mars_2000_Sphere
Angular Unit: Degree (0.0174532925199433299)
Prime Meridian: Reference_Meridian (0.0000000000
Datum: D_Mars_2000_Sphere
Spheroid: Mars_2000_Sphere_IAU_IAG
Semimajor Axis: 3396190.0000000000000000
Select...
New...
Modify...
OK
Cancel
Apply
Descriptive name
Select projection
Fill parameters
Always meters
Select or define new
For Mars, select
Mars 2000 Sphere.prj
GIS for Planetary Mappers
37


ArcCatalog - ArcInfo - E:\PlanetaryGIS_USGS\LibyaMontes_1M\Test_working\Test_Geodatabase.gdb\DemoLibya
File Edit View Go Tools Window ESTS Help
Location:
Stylesheet:
Contents
Preview
Metadata
Name
Type
Copy
Paste
Delete
Rename
Refresh
Arrange
New
Import
Export
Compress File Geodatabase...
Uncompress File Geodatabase...
Upgrade Spatial Reference...
Add Global IDs...
Properties...
Feature Class...
Relationship Class...
Terrain...
Network Dataset...
Topology...
Cadastral Fabric...
Polygon Feature Class From Lines...
Geometric Network...
Creates a new Feature Class
GIS for Planetary Mappers
39


New Feature Class
Field Name
Data Type
OBJECTID
Object ID
SHAPE
Geometry
Click any field to see its properties.
Field Properties
Alias
SHAPE
Allow NULL values
Yes
Geometry Type
Polygon
Avg Num Points
Grid 1
Grid 2
Grid 3
Line
MultiPatch
Multipoint
Point
Polygon
Contains Z values
No
Contains M values
No
Default Shape field
Yes
Spatial Reference
NAD_1983_UTM_Zone_1...
Import...
To add a new field, type the name into an empty row in the Field Name column, click in the Data Type column to choose the data type, then edit the Field Properties.
< Back
Finish
Cancel
GIS for Planetary Mappers
40



GIS for Planetary Mappers 41



GIS for Planetary Mappers 42

Predefined Geodatabases

- USGS creates geodatabase for mappers
- Working with other to standardize

Planetary Mapping The Datamodel's Perspective and GIS Framework, S. van Gasselt, A. Nass

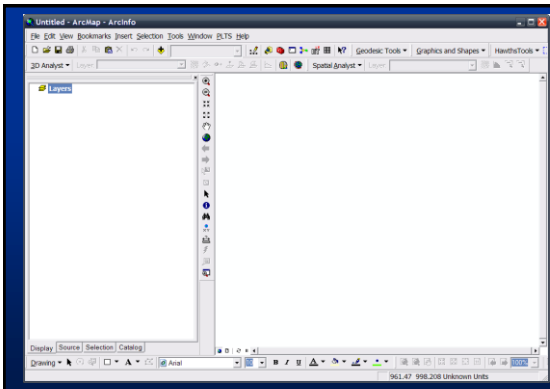
Planetary and Space Science (in review) Special Issue: Geological Mapping of Mars

GIS for Planetary Mappers 43

Open existing ArcMap project

- Good to have multiple projects (~backups)
- Easily transferable to colleagues with GDB
- Organizational preferences abound
- Start ArcMap → Select:
  - New empty map
  - A template
  - An existing map

GIS for Planetary Mappers 44

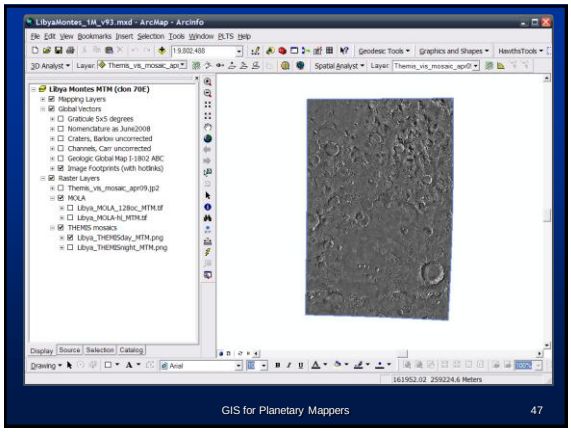


GIS for Planetary Mappers 45

Hands-on (ArcMap/ArcCatalog)

- Goals (using pre-loaded GIS)
  - Add and move data
  - View properties
  - Attributes
  - Domains
  - Raster/vector
  - Menus

GIS for Planetary Mappers 46



GIS for Planetary Mappers 47

Break (10 minutes)

- Next → Editing polylines

GIS for Planetary Mappers 48

Vector Creation, Editing, and Symbols

GIS for Planetary Mappers 49

Vector Creation, Editing, and Symbols

- Introduce Editor toolbar
- Briefly introduce the Advanced Editor toolbar
- Add feature classes (point and lines)
- Create point and line data
- Add attributes (from domains) to features
- Prepare lines before making polygons
- Build polygons from lines
- Use symbols to represent attributes

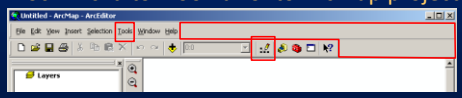
GIS for Planetary Mappers 50

The Editor Toolbar

- Ensure that ArcEditor is functional:
  - Right-click empty ToolBar and select "Editor"

<or>

  - Tools → Customize → Editor (check)
  - Tools → Editor Toolbar (v. 9.3)
- Dock ArcEditor ToolBar onto ArcMap project



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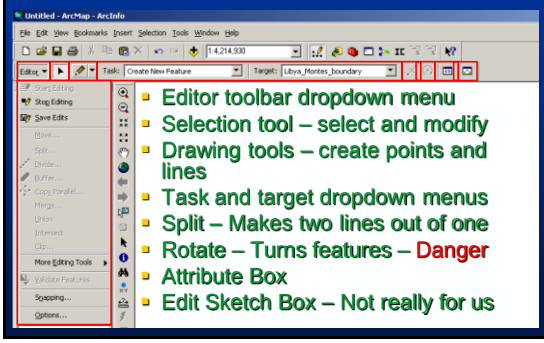
The Editor Toolbar

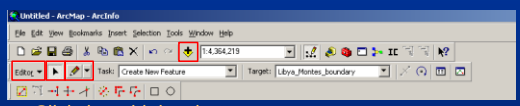


- Editor toolbar dropdown menu
- Selection tool – select and modify
- Drawing tools – create points and lines
- Task and target dropdown menus
- Split – Makes two lines out of one
- Rotate – Turns features – Danger
- Attribute Box
- Edit Sketch Box – Not really for us

The Advanced Editing Toolbar

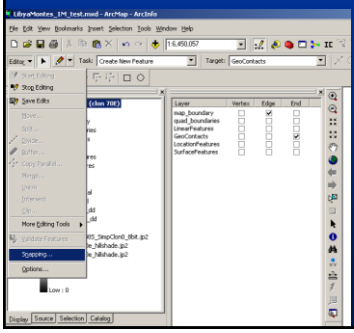
- Copy Features Tool – Self explanatory
- Fillet Tool – Not really used for our purposes
- Extend Feature – extends lines to touch nearest line
- Trim Feature – Trims overshoots back to an intersection
- Line Intersect – Places a node where 2 lines intersect
- Explode Feature – breaks apart multi-part features
- Generalize – reduces the # of vertices in a line
- Smooth – creates a best fit curve to the vertices
- Rectangle and Circle tools

Creating and Editing Data

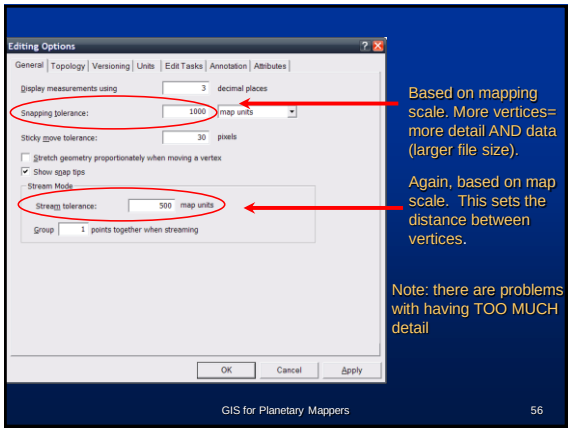


- Click the add data button
  - Navigate to the location of the data you want to edit
- Click on the editor dropdown menu and select "Start Editing"
  - If you have multiple layers from multiple locations, select correct layer
- To create a new feature, select the pencil tool and begin drawing*
- To edit existing features, use the selection tool to select feature, and the dropdown and other edit commands to alter the feature *

Creating and Editing Data



- Before you begin...
  - Set up snapping controls and tolerances



Based on mapping scale. More vertices= more detail AND data (larger file size).

Again, based on map scale. This sets the distance between vertices.

Note: there are problems with having TOO MUCH detail

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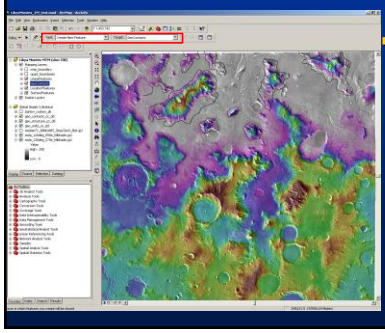
Creating New Data



- Before you begin creating data…
  - Make sure the task box is set to "Create New Feature"
  - Make sure that the target layer is the one to which you want to add new features.

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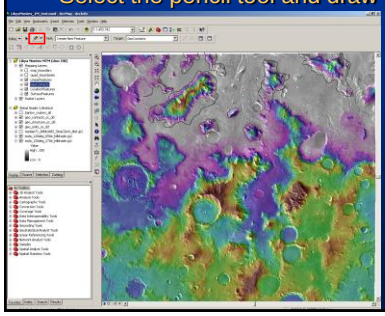
Creating New Data

- Select the pencil tool and draw



- 2 Options:

Click: click the mouse for vertices

Stream: vertices draw as you move the mouse; Toggle F8

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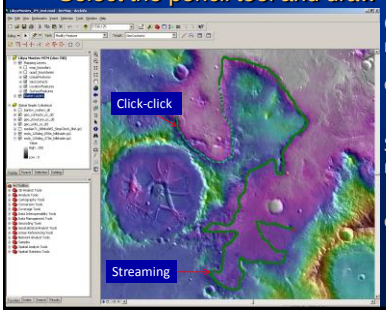
Creating New Data

- Select the pencil tool and draw



Click-click:

Pros: good for small areas, higher detail

Cons: Slow, harder to define curves and corners

Stream:

Pros: Excellent for smaller-scale maps, adjustable tolerance, SPEEDY

Cons: Panning while drawing, too much detail

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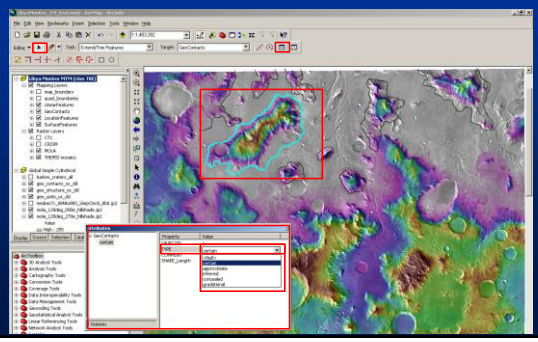
Attributing Data Using Domain



Editing Lines for Polygons

- Lines must define a discrete, enclosed area to generate a polygon
- It may be necessary for you to manually edit the linework
  - Snapping
  - Reshaping
  - Smoothing
- Check your snapping environment and tolerances before editing

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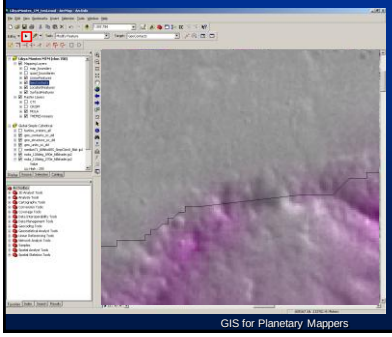
Editing Lines for Polygons



- Using the selection tool, double-click on the feature to modify so the vertices are displayed.
- Position the cursor over the vertex to move, click and drag the vertex to the new location. Let go of the mouse button
- If end, edge, or vertex snapping is turned on, the cursor will be dragged to a snapping location once it is within the specified tolerance.

Digitize, digitize, digitize…

- Tricks:
  - Editor → Snapping
    - Will allow linework to snap to ends or vertices
  - Hit F8 for streaming…hit F8 again for single click
  - F2 Finishes a sketch
  - You can pan while digitizing (not streaming)
  - Attribute while you digitize
    - Use domains
    - Use hand-entered

Summary

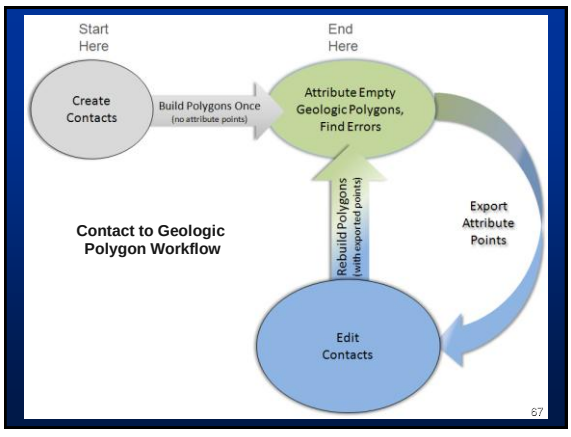
- ArcCatalog utility vs. ArcMap utility
- Opening a new ArcMap project
- Building a new geodatabase
- Creating feature datasets and feature classes
- Adding Domains for attribution

Summary, cont'd

- Adding and starting ArcEditor
- Set snapping environment
- Digitizing – click-click and streaming (F8)
- Attributing digitized information using domains
- Attributing digitized information using hand-entered data

Hands-On (Editing Lines)

- Goals
  - Open Libya project
  - Set snapping
  - Zoom in and digitize
  - Save
- NEXT→ Polygons



Polygon Creation

- Contacts to units
  - Stop editing
  - Arc/Info license: Build polygons from ArcToolbox
  - ArcView license: free 3rd party software to build
    - Tools for Graphics and Shapes
      - http://www.jennessent.com/arcgis/arcgis_extensions.htm

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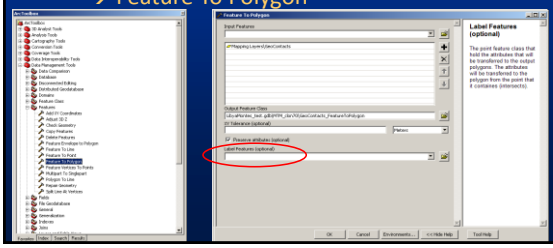
Generating Polygons

- ArcToolbox Method
  - Under Data Management Tools → Features → Feature To Polygon



Generating Polygons

- We do not advocate drawing polygons from the beginning because:
  - Polygons are difficult to edit (slivers, gaps, nested polygons, etc.)
  - Lines generated from polygons will have to be edited (split, merged, attributed, etc.)
  - It is easier and faster to draw, edit and attribute lines using ArcMap

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Generating Polygons

- Recognize that building polygons from the contacts is an iterative process. You would be extremely lucky (or the pope of GIS-town) to only have to do this once.
- If you have attributed a lot of your polygons and have to change a contact or fix a problem, you have not wasted your time. You can export and store the attributes as a point file. That point file can and will be used the next time you build polygons.

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More on Polygon Creation

- Multiple methods
  - Draw contacts and convert to unit polygons
  - Draw unit polygons and extract contacts

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Polygon Creation

- Drawing Polygons
  - Start by using Create New Feature
    - ****New polygons cannot overlap, overlay, abut or touch another polygon in the same layer in anyway****
  - Autocomplete
    - Use when adding adjacent or internal polygons
    - Start inside an existing polygon
    - Draw the polygon around the feature of interest
    - End the polygon inside an existing polygon
- Demonstration

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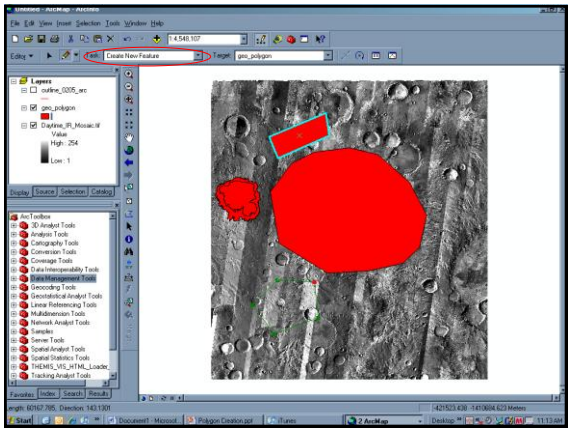

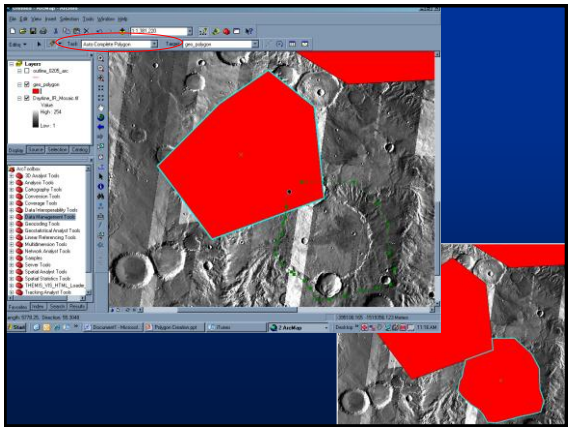

Polygon Editing

- Editing existing polygons
  - –Cut Polygons
    - Select the polygon to edit
    - Start line outside of selected polygon
    - Draw the line along contact
    - End outside of selected polygon
    - See also Advanced Topology Editing
- Demonstration

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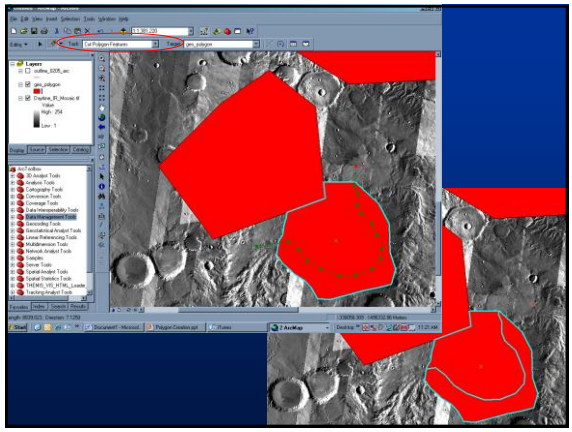

Polygon Editing

- Editing existing polygons layers
  - Append Multiple Layers
- Demonstration

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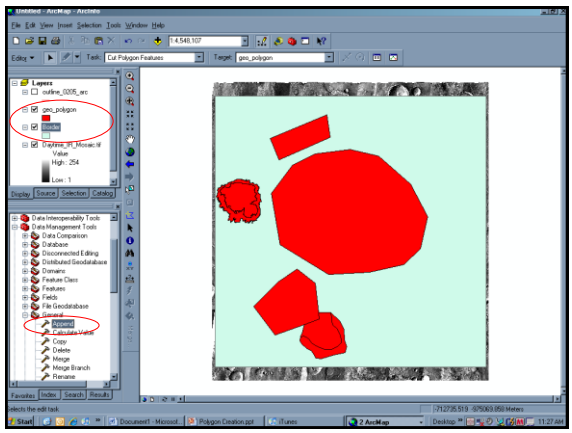
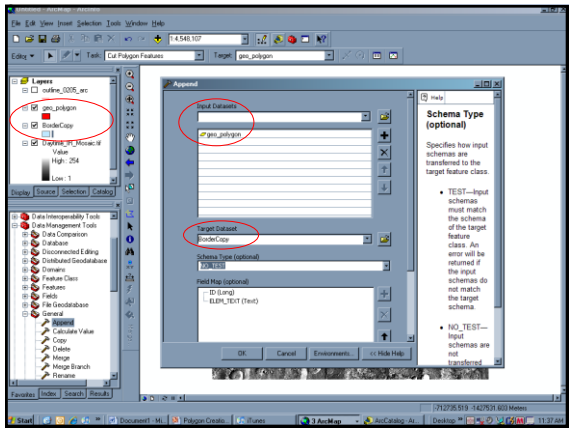
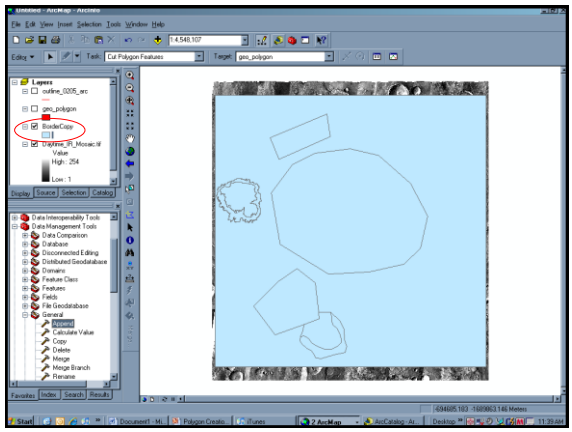
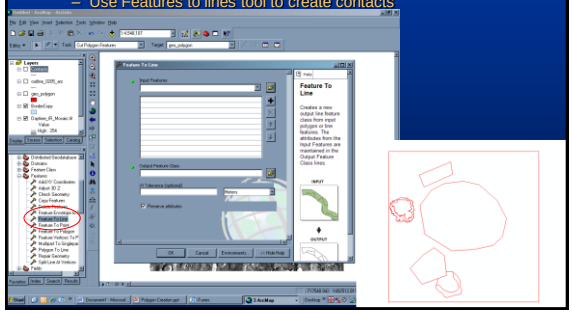






Polygon Editing

- Extract contacts from polygon file
  - Use Features to lines tool to create contacts



Checklist for GIS Map Finalization

Checklist for Map Finalization

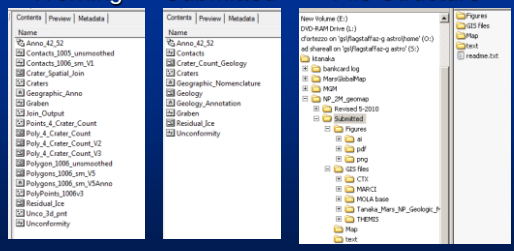
- GIS vector features
  - Contacts/Linear Features (lines)
    - Contacts should be snapped to other contacts
    - Contacts should match polygon edges
    - Lines should be smoothed so they're appearance is not angular
    - Attributes defined in the table and displayed with unique symbology
    - Symbology closely follow the FGDC Cartographic Standards
  - Geologic Units (polygons)
    - Must not contain sliver polygons
    - Polygons must not overlap
    - Polygons colorized by unit type
    - Must have labels or annotation
    - Table should contain at least the unit symbol and unit name
  - Point Features (points)
    - Uniquely attributed and symbolized
    - Labeled if necessary
    - Sized so they can be seen at the printable map scale

Checklist for Map Finalization

- GIS Raster Data
  - For submission:
    - Include the USGS base map
    - Include the MOLA DEM and shaded relief
    - All high-resolution datasets used while mapping should be excluded, down sampled, or included as figures, footprint files, supplemental data
- Submission Package
  - Include all pertinent GIS vector files with clear and logical naming conventions (Geology, Contacts, Linear Features, etc.)
    - Don't include names like: *'geology_polygons_edit_ver_2_12122009_what_is_this'*
  - Include USGS base map and MOLA data
  - PDF, exported from Arc at full scale
- METADATA
  - Try it, you may like it

Example of Geodatabase and Submission

- Working
- Submitted
- File Structure



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Symbology

- Representing different attributes with unique symbols in ArcMap
  - Double click on the name of the feature in the Table of Contents

<or>

  - Right click on the name of the feature in the Table of Contents, and select Properties

Choose the Symbology tab

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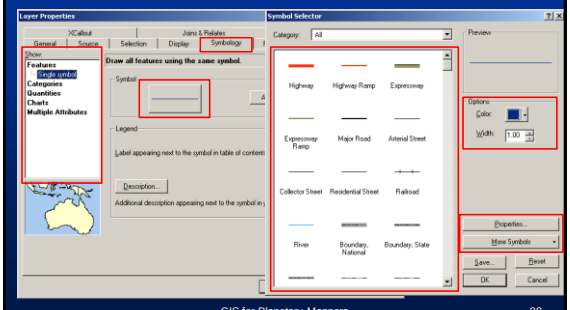
Symbology



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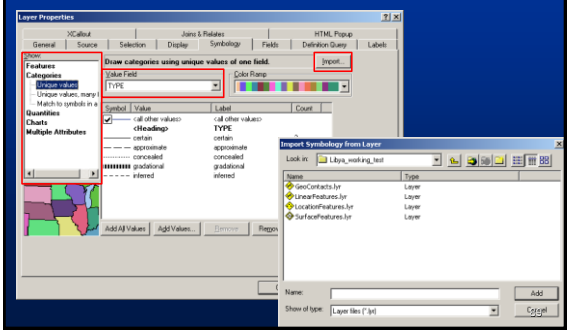
Symbology



Questions?